PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2003-286517

(43)Date of publication of application : 10.10.2003

(51)Int.Cl. C21D 1/18
C21D 1/00

(21)Application number : 2002-094301

(22)Date of filing : 29.03.2002

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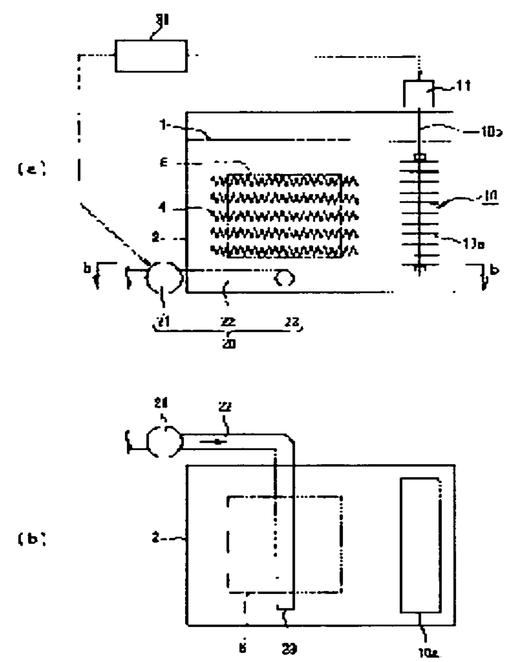
(54) QUENCHING METHOD AND QUENCHING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a quenching method which controls fluctuation of a cooling power in quenching treatment, and controls deformation and distortion generated during quenching, and to provide a quenching device.

SOLUTION: This quenching method comprises vibration stirring a liquid coolant 2 for immersing a workpiece (an article to be treated) therein and cooling it, with a vibration stirrer 10, and then jet stirring it with a jet stirrer 20, to control the fluctuation of the cooling power.



LEGAL STATUS

[Date of request for examination] 17.11.2004

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]

[Claim 1] The hardening approach characterized by stirring by the jet in the hardening approach immersed in the coolant in a hardening cooling pool in a processed material after stirring said coolant by oscillation.

[Claim 2] The hardening approach characterized by stirring by the jet in the hardening approach immersed in the coolant in a hardening cooling pool in a processed material after stirring said coolant by an oscillation and the jet.

[Claim 3] The hardening approach characterized by stirring by an oscillation and the jet in the hardening approach immersed in the coolant in a hardening cooling pool in a processed material after stirring said coolant by oscillation, and stirring by the jet after that further.

[Claim 4] The hardening approach characterized by stirring by an oscillation and the jet in the hardening approach immersed in the coolant in a hardening cooling pool in a processed material after stirring said coolant by oscillation.

[Claim 5] The hardening approach characterized by stirring said coolant by the jet in the convection-current phase which is the cooling process of said coolant in the steam film phase which is the cooling process of said coolant in the hardening approach immersed in the coolant in a hardening cooling pool in a processed material while stirring said coolant by oscillation.

[Claim 6] The hardening approach according to claim 5 characterized by changing the stirring approach of said coolant from stirring by oscillation to stirring by the jet in the ebullition phase which is the cooling process of said coolant.

[Claim 7] The hardening approach characterized by stirring in the hardening approach immersed in a processed material at the coolant in a hardening cooling pool by controlling according to an individual while hardening actuation and a halt of stirring by oscillation, and stirring by the jet for said coolant.

[Claim 8] The hardening approach according to claim 7 characterized by stirring by controlling said coolant according to the strength individual of stirring by oscillation, and stirring by the jet.

[Claim 9] Hardening equipment characterized by controlling the stirring approach to stir by the jet in the hardening equipment immersed in the coolant in a hardening cooling pool in a processed material after stirring said coolant by predetermined time oscillation.

[Claim 10] Hardening equipment characterized by controlling the stirring approach to stir by the jet in the hardening equipment immersed in the coolant in a hardening cooling pool in a processed material after stirring said coolant by a predetermined time oscillation and the jet.

[Claim 11] Hardening equipment characterized by controlling the stirring approach to stir by an oscillation and the jet in the hardening equipment immersed in the coolant in a hardening cooling pool in a processed material after stirring said coolant by predetermined time oscillation, and to stir by the jet after that further.
[Claim 12] Hardening equipment characterized by controlling the stirring approach to stir by an oscillation and the jet in the hardening equipment immersed in the coolant in a hardening cooling pool in a processed material after stirring said coolant by predetermined time oscillation.
[Claim 13] It is hardening equipment given in claim 9 characterized by the ability of the multistage type oscillating stirrer concerned to adjust oscillation frequency while generating said oscillation with the multistage type oscillating stirrer which consists of a diaphragm of two or more sheets thru/or any 1 term of 12.
[Claim 14] Hardening equipment characterized by controlling the stirring approach to stir said coolant by the jet in the convection-current phase which is the cooling process of said coolant in the steam film phase which is the cooling process of said coolant in the hardening equipment immersed in the coolant in a hardening cooling pool in a processed material while stirring said coolant by oscillation.
[Claim 15] Hardening equipment according to claim 14 characterized by changing the stirring approach of said coolant from stirring by oscillation to stirring by the jet in the ebullition phase which is the cooling process of said coolant.
[Claim 16] It is hardening equipment according to claim 14 or 15 characterized by the ability of the multistage type oscillating stirrer concerned to adjust oscillation frequency while generating said oscillation with the multistage type oscillating stirrer which consists of a diaphragm of two or more sheets.

[Translation done.]

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] About the hardening approach and hardening equipment in heat treatment of a metal, this invention relates to an effective technique, in order to press down the deformation and distortion at the time of hardening especially.
[0002]
[Description of the Prior Art] Generally, hardening equipment as been the actuation which it is immersed into suitable coolant, such as an oil, water, and a water-soluble cooling agent, after hardening heats steel to the temperature more than the transformation point, and is cooled quickly, for example, shown in drawing 2121 is used. This hardening equipment is equipped with the cooling pool 2 which stored the coolant 1 which is hardening material, the propeller agitator 3 put aside and arranged in this cooling pool 2, and the straightening vane 5 which prepares the liquid flow 4 in the cooling pool 2 by the propeller agitator 3 (flow) so that it may go to the upper part from the bottom of the tank. But there are some which use the pump for jets instead of the propeller agitator 3.
[0003] The approach of carrying out hardening processing of the processed material made from steel or special steel (henceforth a work piece) using this hardening equipment is as follows. That is, the propeller agitator 3 is started beforehand and the flow 4 of the coolant 1 is made in the cooling pool 2. The hot work piece separately heated with the heating furnace more than the transformation point is contained in the containers 6, such as a basket, and this is immersed in the coolant 1 of a cooling pool 2. By exposing to the flow 4 of the coolant in this way, it quenches a work piece and it is hardened.
[0004]
[Problem(s) to be Solved by the Invention] In this case, it is immersed into the coolant 1 by dropping the work piece in a container 6 with rise-and-fall means, such as an elevator, and hardening is performed. Therefore, cooling begins from the lower part of a container 6, and has the inclination for the upper part to be cooled gradually. Furthermore, it is difficult for that it is the upflow which goes to the upper part to also involve, and for the flow 4 of the coolant to cool the whole work piece which is a processed material from the bottom of the tank section, to homogeneity over the upper part and the lower part. Therefore, when a work piece is a simple substance, deformation takes place, and when work pieces are many lots, variation will occur with the whole lot.
[0005] If the quantity and size of a work piece are small, since there is little how the flow 4 of the coolant 1 by the propeller agitator 3 is disturbed, good hardening without

variation will still be easy to be performed. However, in common hardening equipment, a hundreds of kg to about 1000kg work piece is hardened by weight at once. Therefore, the flow 4 in a cooling pool 2 will be interrupted, in the location especially the upper part, and the lower part of the work piece in a cooling pool 2, cooling rates will differ greatly and the variation in cooling will become large. Consequently, the nonconformity that variation will arise was in the hardening hardness of a work piece, and hardening deformation of distortion, deflection, etc.

[0006] Here, when hardening deformation of the distortion, deflection, etc. resulting from heat treatment is large, the cut process of a work piece is needed after heat treatment. However, with high-degree-of-accuracy-izing of heat treatment components, hardening deformation of distortion, deflection, etc. is suppressed as much as possible, and it is anxious for skipping the cut process after heat treatment in recent years. This invention makes it the technical problem to offer the hardening approach and hardening equipment which can be made in view of the above-mentioned situation, can control the variation in the cooling power in hardening processing, and can control the deformation generated at the time of hardening, and distortion.

[0007]

[Means for Solving the Problem] In order to solve such a technical problem, as a result of this invention persons' inquiring wholeheartedly, the steam film of the quenching oil formed on the surface of a processed material at the time of hardening discovered enlarging hardening deformation of distortion, deflection, etc., and resulted in this invention because an ununiformity breaks with the configuration and location of a processed material.

[0008] In the hardening approach immersed in the coolant in a hardening cooling pool in a processed material, after the first hardening approach of this invention stirs said coolant by oscillation, it is characterized by stirring by the jet. In the hardening approach immersed in the coolant in a hardening cooling pool in a processed material, after the second hardening approach of this invention stirs said coolant by an oscillation and the jet, it is characterized by stirring by the jet.

[0009] In the hardening approach immersed in the coolant in a hardening cooling pool in a processed material, after the third hardening approach of this invention stirs said coolant by oscillation, it is characterized by controlling the variation in cooling power by stirring by an oscillation and the jet and stirring by the jet after that further. In the hardening approach immersed in the coolant in a hardening cooling pool in a processed material, after the fourth hardening approach of this invention stirs said coolant by oscillation, it is characterized by stirring by an oscillation and the jet.

[0010] It may be made to operate stirring by the jet, and you may make it operate stirring by the jet after an appropriate time here, since stirring by oscillation is stopped thoroughly at the same time it stops stirring by the oscillation "is stirred by the jet after stirring by oscillation" in the first [of this invention] thru/or fourth hardening approach. Moreover, you may make it operate stirring by the jet from from while performing stirring by oscillation.

[0011] In the hardening approach immersed in the coolant in a hardening cooling pool in a processed material, in the steam film phase which is the cooling process of said coolant, the fifth hardening approach of this invention is characterized by stirring said coolant by the jet in the convection-current phase which is the cooling process of said coolant while it stirs said coolant by oscillation. Moreover, as for the fifth hardening approach of this invention, in the ebullition phase which is the cooling process of said coolant, it is desirable to change the stirring approach of said coolant from stirring by

oscillation to stirring by the jet.
[0012] Here, in the fifth hardening approach of this invention, a "convection-current phase" points out the change of state of the coolant in change with the temperature and time amount to them, when cooling in them after making the "steam film phase" and "ebullition phase" list which are the cooling process of the coolant heat a processed material. The sixth hardening approach of this invention is controlling a processed material according to an individual to the coolant in a hardening cooling pool, while hardening actuation and a halt of stirring by oscillation, and stirring by the jet for said coolant in the immersed hardening approach, and is characterized by stirring.
[0013] Moreover, the sixth hardening approach of this invention is controlling said coolant according to the strength individual of stirring by oscillation, and stirring by the jet, and stirring is desirable. In the hardening equipment immersed in the coolant in a hardening cooling pool in a processed material, after the first hardening equipment of this invention stirs said coolant by predetermined time oscillation, it is characterized by controlling the stirring approach to stir by the jet.
[0014] In the hardening equipment immersed in the coolant in a hardening cooling pool in a processed material, after the second hardening equipment of this invention stirs said coolant by a predetermined time oscillation and the jet, it is characterized by controlling the stirring approach to stir by the jet. In the hardening equipment immersed in the coolant in a hardening cooling pool in a processed material, after the third hardening equipment of this invention stirs said coolant by predetermined time oscillation, it is characterized by controlling the stirring approach to stir by an oscillation and the jet and to stir by the jet after that further.
[0015] In the hardening equipment immersed in the coolant in a hardening cooling pool in a processed material, after the fourth hardening equipment of this invention stirs said coolant by predetermined time oscillation, it is characterized by controlling the stirring approach to stir by an oscillation and the jet. Moreover, in the first [of this invention] thru/or fourth hardening equipment, while generating said oscillation with the multistage type oscillating stirrer which consists of a diaphragm of two or more sheets, as for the multistage type oscillating stirrer concerned, it is desirable for oscillation frequency to be adjusted.
[0016] In the hardening equipment immersed in the coolant in a hardening cooling pool in a processed material, in the steam film phase which is the cooling process of said coolant, the fifth hardening equipment of this invention is characterized by controlling the stirring approach to stir said coolant by the jet in the convection-current phase which is the cooling process of said coolant while it stirs said coolant by oscillation.
[0017] Moreover, as for the fifth hardening equipment of this invention, in the ebullition phase which is the cooling process of said coolant, it is desirable to change the stirring approach of said coolant from stirring by oscillation to stirring by the jet. Furthermore, while the fifth hardening equipment of this invention generates said oscillation with the multistage type oscillating stirrer which consists of a diaphragm of two or more sheets, as for the multistage type oscillating stirrer concerned, it is desirable for oscillation frequency to be adjusted.
[0018] After stirring the coolant which cools a processed material by oscillation, while destroying to homogeneity the steam film of the coolant (quenching oil) formed in a processed material front face by stirring by the jet at the time of hardening by oscillating stirring according to the first hardening approach of this invention, it becomes possible to make homogeneity carry out diffusion disappearance of the

removed steam by jet stirring. For this reason, the variation in cooling power is abolished and it becomes possible to control hardening deformation of distortion, deflection, etc. of the processed material generated at the time of hardening.
[0019] According to the second thru/or fourth hardening approach in this invention, it becomes possible to perform optimal stirring according to a processed material by changing the combination of an oscillation and a jet according to the configuration of a processed material, or the magnitude of a container. While stirring the coolant by oscillation in the steam film phase which is the cooling process of the coolant according to the fifth hardening approach of this invention In the convection-current phase which is the cooling process of the coolant, while destroying to homogeneity the steam film formed in a processed material front face in a steam film phase at the time of hardening by stirring the coolant by the jet Homogeneity can be made to carry out diffusion disappearance of the steam removed from the processed material front face in a subsequent ebullition phase and a subsequent convection-current phase. Therefore, it becomes possible to control hardening deformation of distortion, deflection, etc. of the processed material generated at the time of hardening with strong cooling power.
[0020] While according to the sixth hardening approach of this invention hardening actuation and a halt of stirring by oscillation, and stirring by the jet and controlling the coolant according to an individual, it becomes possible by stirring by controlling according to the strength individual of stirring by oscillation, and stirring by the jet to perform optimal stirring according to the configuration of a processed material, or the magnitude of a container. Therefore, the variation in cooling power is abolished and it becomes possible to control hardening deformation of distortion, deflection, etc. of the processed material generated at the time of hardening.
[0021] According to the hardening equipment of this invention, the hardening approach of this invention is easily realizable.
[0022]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing. Drawing 1 is the sectional view which showed typically 1 operation gestalt of the hardening equipment in this invention, and met the b-b line [in / (a) and / in (b) / drawing 1 (a)]. [a forward sectional view] In addition, the same sign is given to the same part as the former.
[0023] The cooling pool 2 in which the hardening equipment in this operation gestalt stored the coolant 1 as shown in drawing 1 , The container 6 which contains the work piece (processed material) with which it is arranged in the center section of this cooling pool 2, and hardening processing is made, It has the controller 30 which performs change to the oscillating agitator 10 put aside and arranged in this cooling pool 2, the jet agitator 20 arranged so that the jet stirring tubing 22 may cross the lower part of a container 6, and the oscillating agitator 10 and the jet agitator 20, and adjustment of each stirring reinforcement.
[0024] The oscillating agitator 10 is multistage type rocking equipment which has multistage diaphragm 10a arranged up and down at equal intervals, and stirs the coolant 1 by oscillation. The number of stages of diaphragm 10a is decided according to the height (depth) of the container 6 which contains a work piece. Such diaphragm 10a is connected through common shaft 10b, and is engrossed in the coolant 1. Here, the edge of shaft 10b is connected to the driving gear 11 which contained the frequency regulator (not shown) as a frequency adjustment device which adjusts the frequency of an oscillation.

[0025] According to the configuration and construction material of the work piece hardened, a frequency regulator is changing oscillation frequency by the cooling process, and can adjust the reinforcement of stirring by oscillation. The jet agitator 20 is equipped with the jet pump 21 which sends out a jet, the jet tubing 22 which conveys a jet, and the exhaust nozzle 23 which counters the wall of a cooling pool 2 and spouts a jet. The jet spouted from this exhaust nozzle 23 turns into a upflow which goes above the lower part of a cooling pool 2, and stirs the coolant 1 by the jet. The amount of blowouts of this jet can adjust the reinforcement of stirring by the jet according to the configuration and construction material of the work piece hardened.
[0026] That is, he is trying to form a lifting jet by the jet pump 21 instead of the lifting liquid flow 4 by the propeller agitator 3 of the conventional example shown in drawing 21 . The controller 30 is controlling the timing which performs the change to the oscillating agitator 10 and the jet agitator 20 according to the configuration and construction material of the work piece hardened. Moreover, in order to adjust the reinforcement of stirring in the oscillating agitator 10, while controlling a frequency regulator, in order to adjust the reinforcement of stirring in the jet agitator 20, the amount of blowouts spouted from a jet pump 22 is controlled.
[0027] Next, the hardening approach using the hardening equipment which has the above-mentioned configuration is explained. Drawing 2 is a timing diagram which shows the operating state of oscillating stirring and jet stirring. First, the oscillating agitator 10 is operated and the horizontal oscillating style 4 is formed in the coolant 1 in a cooling pool 2. And you contain the hot work piece made to heat with a heating furnace separately more than the transformation point in a container 6, for example, make it immersed in the coolant 1 of a cooling pool 2 in an elevator (not shown).
[0028] Subsequently, as shown in drawing 2 , when the steam film phase where the predetermined time deed and the work-piece front face were covered with the steam film ends oscillating stirring by the oscillating agitator 10 and it becomes an ebullition phase, actuation of the oscillating agitator 10 is changed, and the jet agitator 20 is operated. Here, predetermined time will be required by the time the oscillating agitator 10 and the jet agitator 20 change thoroughly. For this reason, the timing which expects this time amount and changes the oscillating agitator 10 and the jet agitator 20 is determined.
[0029] Here, as for the timing which changes the oscillating agitator 10 and the jet agitator 20, it is desirable to determine with the configuration of the work piece to harden, an ingredient, or magnitude. You may make it determine beforehand the optimal timing for the work piece which tries and hardens various combination patterns of stirring by an oscillation or the jet as the decision approach of this timing, for example. Moreover, the generating time amount of the steam film phase in the cooling process of the coolant, an ebullition phase, and a convection-current phase is measured beforehand, and you may make it determine timing according to those cooling process generating time amount according to the work piece to harden.
[0030] And a work piece is hardened by cooling the work piece of an ebullition phase and a convection-current phase by jet stirring by the jet agitator 20. According to the hardening approach in this operation gestalt, the steam film of a work piece can be destroyed to homogeneity, the horizontal oscillating style 4 being formed in the coolant 1 in a cooling pool 1, and crossing the upper part in a container 6, CHUBU ENGINEERING CORPORATION, and the lower part by stirring by adding an oscillation to the coolant 1 in the steam film phase of the coolant 1.
[0031] Moreover, in the ebullition phase and convection-current phase of the coolant

1, the steam removed by oscillating stirring can raise the homogeneity of diffusion ****** and cooling to the whole quickly by stirring the coolant 1 by the jet. That is, after stirring the coolant by oscillation, by stirring by the jet, the whole work piece hardens to homogeneity and it becomes possible to control hardening deformation of distortion, deflection, etc.

[0032] According to the hardening approach of this operation gestalt, the cooling condition of the coolant 1 performs only stirring by oscillation in a steam film phase, and the cooling condition of the coolant 1 was made to perform only stirring by the jet here in the ebullition phase and the convection-current phase, but If the oscillating agitator 10 is operated at least at the time of cooling initiation and it is made to operate the jet agitator 20 at the time of cooling termination, it will not restrict to this. For example, as shown in drawing 3 , oscillating stirring and jet stirring are performed at the time of cooling initiation, and it may be made to perform only jet stirring after predetermined time progress. Moreover, as shown in drawing 4 , oscillating stirring is performed at the time of cooling initiation, oscillating stirring and jet stirring are simultaneously performed after predetermined time progress, and it may be made to perform only jet stirring after that further. Furthermore, as shown in drawing 5 , oscillating stirring is performed at the time of cooling initiation, and it may be made to perform oscillating stirring and jet stirring after predetermined time progress simultaneously.

[0033] Moreover, as the stirring situation of oscillating stirring and jet stirring can be changed according to the configuration and construction material of the work piece hardened, for example, it is shown in drawing 6 , further, it stops and may be made to change to stirring by weak oscillation after predetermined time progress, and to stir by strong oscillation at the time of cooling initiation, and for stirring according to an oscillation in after predetermined time progress to stir by the jet. Moreover, as shown in drawing 7 , it changes to stirring by the weak oscillation and the strong jet after predetermined time progress, and after predetermined time progress, stirring by oscillation stops further, and it may be made to stir by strong oscillation at the time of cooling initiation, and to stir only by the strong jet. Furthermore, at the time of cooling initiation, it stirs by strong oscillation, and changes to stirring by the weak oscillation and the strong jet after predetermined time progress, and it stops and you may make it change stirring by oscillation to stirring only by the weak jet after predetermined time progress further, as shown in drawing 8 . Furthermore, as shown in drawing 9 , it changes to stirring by the weak oscillation and the strong jet after predetermined time progress, and after predetermined time progress, stirring by oscillation stops further, and it may be made to stir by the strong oscillation and the weak jet at the time of cooling initiation, and to stir only by the weak jet.

[0034] Furthermore, in the hardening approach of this operation gestalt, although the controller 30 was made to perform change of the oscillating agitator 10 and the jet agitator 20, and adjustment of those stirring reinforcement, it may be made to carry out not only by this but by handicraft.

[0035]

[Example] Next, the effectiveness of this invention is verified based on the following examples. With the heating furnace, C mold test piece (SUJ2) heated to hardening temperature (830 degrees C) was thrown in in the cooling pool, and it hardened under the following conditions.

(1) The cooling approach (example of this invention)

Jet stirring is performed after performing example 1 oscillating stirring for 4 seconds.

Jet stirring is performed after performing example 2 oscillating stirring for 8 seconds.
Jet stirring is performed after performing example 3 oscillating stirring for 12 seconds.
Jet stirring is performed after performing example 4 oscillating stirring for 16 seconds.
[0036] Here, after performing oscillating stirring request time, actuation of this oscillating agitator is suspended and the jet agitator was operated instead, and by the time the change of an agitator was completed, it required for about 4 seconds. As for time amount until this change is completed, oscillating stirring and jet stirring will be performed simultaneously.
(Example of a comparison)
Only example of comparison 1 jet stirring is performed.
Only example of comparison 2 oscillating stirring is performed.
Example of comparison 3 oscillating stirring and jet stirring are performed simultaneously.
Oscillating stirring is performed after performing example of comparison 4 jet stirring for 8 seconds.
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About the strength of oscillating stirring, when asked for the relation between a flow rate and oscillation frequency by preliminary experiment, the straight-line relation shown in drawing 10 was obtained.
[0037] late about cooling speed -- being quick -- it changes greatly with classes of oil coolant. Then, about the above-mentioned oil coolant kind FW243, when asked for the relation between the cooling speed (the number of seconds) from the temperature of 850 degrees C to 300 degrees C, and oscillation frequency by preliminary experiment, the relation of drawing 11 was obtained. That is, when the number of cooling seconds maintains 30Hz from 10Hz to abbreviation regularity on the base of 60 seconds and oscillation frequency exceeds the frequency of 30Hz, it turns out that it becomes quick gradually and is the quickest with the number 45 seconds of cooling seconds on the frequency of 40Hz. On the other hand, if the frequency of 40Hz is exceeded, shortly, it will become late gradually and will exceed frequency 60 seconds a little. However, if the number of cooling seconds exceeds 60 seconds on the frequency of 60Hz, it will become reverse early suddenly.
[0038] Thus, although cooling speed changes with change of oscillation frequency, if cooling will be overdue, and a good hardening result will not be obtained, if a frequency is set to less than 10Hz but the frequency of 60Hz is exceeded on the other hand, although it will be based also on the viscosity of an oil, an oscillation will be in an idle condition, and a too good hardening result is not obtained. From this result, 40Hz was adopted as optimal oscillation frequency in this example which makes the oil coolant kind FW243 the coolant.
[0039] In accordance with this, the flow rate of the jet in jet stirring was set to 2/Hr 5m that it should correspond to the oscillation frequency of 40Hz. And it set to the test piece hardened by each cooling approach, and the amount of distortion of the test piece before and behind hardening and whenever [internal hardening] were computed based on the following test conditions. Drawing 12 is drawing showing the amount of distortion of a test piece. Drawing 13 </A> - drawing 19 are drawings showing the internal degree of hardness of the test piece hardened on each cooling condition. In addition, each of drawing 13 - drawing 19 shows the internal degree of hardness about

the test piece of No.1-No.3 which have vacated and arranged predetermined spacing sequentially from an oscillating agitator side in the same container. Drawing 20 is drawing showing the relation between the cooldown delay of a processed material, and the cooling condition of a processed material.
(The amount test condition of distortion) It hardened on 830 degrees C and the heating conditions for 60 minutes, opening of the test piece before and behind the hardening was measured by the micrometer, and change of the dimension was made into the amount of distortion.
(Internal degree-of-hardness Measuring condition) It hardened on 830 degrees C and the heating conditions for 60 minutes, and the internal degree of hardness of the maximum thickness section in the test piece after the hardening was measured using the Vickers hardness number meter.
[0040] In the example 3 of a comparison which performed simultaneously the examples 1-4 and oscillating stirring which performed jet stirring after performing oscillating stirring from the result shown in drawing 12 compared with the example 2 of a comparison which performed only the example 1 of a comparison and oscillating stirring which performed only jet stirring, and jet stirring, that there are few amounts of distortion of a test piece understands. Moreover, after carrying out jet stirring to reverse, it understands that the amount of distortion of a test piece is large like the example 1 of a comparison, and the example 2 of a comparison as an example also in the example 4 of a comparison which performed oscillating stirring. This showed that change arose in the amount of distortion by changing the combination of oscillating stirring and jet stirring. That is, according to the configuration of a processed material, and construction material, it has checked that distortion could be adjusted by adjusting the combination of oscillating stirring and jet stirring.
[0041] Moreover, in the example 2 of a comparison which performed only the example 1 of a comparison and oscillating stirring which performed only jet stirring, and the example 3 of a comparison which performed oscillating stirring and jet stirring in the list simultaneously, it was checked from the result shown in drawing 13 - drawing 19 that variation arises in an internal degree of hardness. In order [both] to secure a uniform degree of hardness from this, while performing oscillating stirring and jet stirring to the coolant, it turns out that the activation sequence of oscillating stirring and jet stirring is important. Moreover, after performing oscillating stirring 12 seconds or more, also in the example 3 and example 4 which performed jet stirring, it was checked that variation has arisen in the internal degree of hardness. In order to secure a uniform degree of hardness from this, it turns out that the change timing to stirring by the jet from stirring by oscillation is important.
[0042] Furthermore, the result shown in drawing 20 shows changing from a steam film phase to an ebullition phase after about 4 seconds, after starting cooling in general, and changing from the ebullition phase to the convection-current phase after about 10 seconds further, after starting cooling, even if the cooling condition of the coolant is the case of which cooling conditions. That is, in order to realize an example 1 and an example 2, it understands [that the cooling condition of the coolant performs oscillating stirring in a steam film phase (from the time of cooling initiation to about 8 seconds), and the cooling condition of the coolant should just be made to perform jet stirring in the suitable timing of an ebullition phase and a convection-current phase in consideration of the time amount concerning the change of oscillating stirring and jet stirring, and].
[0043] That is, in the examples 1 and 2 which the cooling process of the coolant

stirred by oscillation in the steam film phase, and the cooling process of the coolant stirred by the jet in the ebullition phase and the convection-current phase from the above-mentioned result, hardening deformation of distortion, deflection, etc. was controlled and it has been checked that the hardening processing which has a uniform degree of hardness had been made.

[0044]

[Effect of the Invention] While destroying to homogeneity the steam film of the quenching oil formed in a processed material front face by stirring by the jet at the time of hardening by oscillating stirring according to the hardening approach of this invention after stirring the coolant which cools a processed material by oscillation combining stirring by oscillation, and stirring by the jet as explained above, it becomes that it is possible to make homogeneity carry out diffusion disappearance of the removed steam by jet stirring. For this reason, it becomes possible to control the variation in cooling power and to control hardening deformation of distortion, deflection, etc. of the processed material generated at the time of hardening. According to the hardening equipment of this invention, it becomes possible to realize the hardening approach of this invention easily.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view which showed typically 1 operation gestalt of the hardening equipment in this invention, and met the b-b line [in / (a) and / in (b) / drawing 1 (a)]. [a forward sectional view]
[Drawing 2] It is the timing diagram which shows one operating state of oscillating stirring and jet stirring.
[Drawing 3] It is the timing diagram which shows other operating states of oscillating stirring and jet stirring.
[Drawing 4] It is the timing diagram which shows other operating states of oscillating stirring and jet stirring.
[Drawing 5] It is the timing diagram which shows other operating states of oscillating stirring and jet stirring.
[Drawing 6] It is the timing diagram which shows 1 operation gestalt of the operating state of oscillating stirring to the cooldown delay of a processed material, and jet stirring.
[Drawing 7] It is the timing diagram which shows other operation gestalten of the operating state of oscillating stirring to the cooldown delay of a processed material, and jet stirring.
[Drawing 8] It is the timing diagram which shows other operation gestalten of the operating state of oscillating stirring to the cooldown delay of a processed material, and jet stirring.
[Drawing 9] It is the timing diagram which shows other operation gestalten of the operating state of oscillating stirring to the cooldown delay of a processed material, and jet stirring.
[Drawing 10] It is the graph which shows the flow rate of the jet in oscillating stirring, and relation with oscillation frequency.
[Drawing 11] It is the graph which shows the relation between the oscillation frequency in this invention, and a cooling rate.
[Drawing 12] It is the graph which shows the distortion yield in the hardening approach.

[Drawing 13] It is the graph which shows the internal degree of hardness at the time of hardening only by oscillating stirring.
[Drawing 14] It is the graph which shows the internal degree of hardness at the time of hardening only by jet stirring.
[Drawing 15] After performing oscillating stirring for 4 seconds, it is the graph which shows the internal degree of hardness in the hardening approach which was made to perform jet stirring.

[Drawing 16] After performing oscillating stirring for 8 seconds, it is the graph which shows the internal degree of hardness in the hardening approach which was made to perform jet stirring.
[Drawing 17] After performing oscillating stirring for 12 seconds, it is the graph which shows the internal degree of hardness in the hardening approach which was made to perform jet stirring.
[Drawing 18] After performing oscillating stirring for 16 seconds, it is the graph which shows the internal degree of hardness in the hardening approach which was made to perform jet stirring.
[Drawing 19] It is the graph which shows the internal degree of hardness in the hardening approach which was made to perform oscillating stirring and jet stirring simultaneously.
[Drawing 20] It is drawing showing the relation between the cooldown delay of a processed material, and the cooling condition of the coolant.
[Drawing 21] It is the forward sectional view showing 1 operation gestalt of conventional hardening equipment typically.
[Description of Notations]
1 Coolant
2 Cooling Pool
3 Propeller Agitator
4 Oscillating Style (Flow)
6 Container
10 Oscillating Agitator (Oscillating Stirring Means)
20 Jet Agitator (Jet Stirring Means)
30 Controller

[Translation done.]

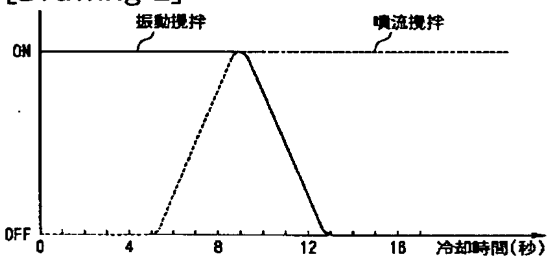
* NOTICES *

JPO and NCIPI are not responsible for any
damages caused by the use of this translation.

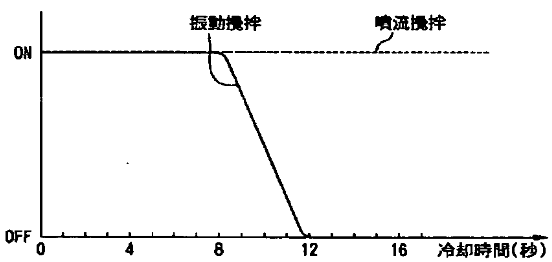
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

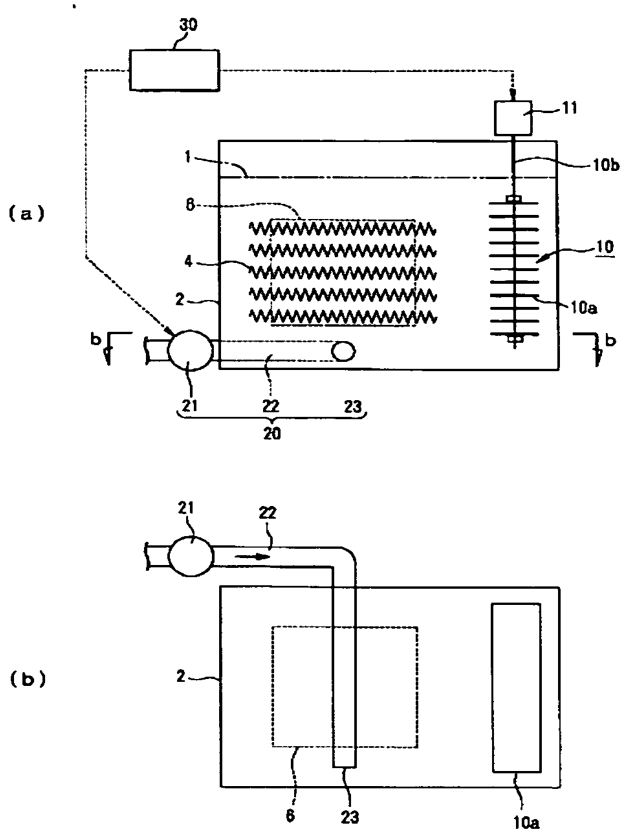
[Drawing 2]



[Drawing 3]



[Drawing 1]



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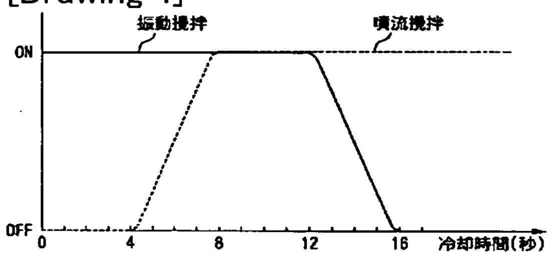

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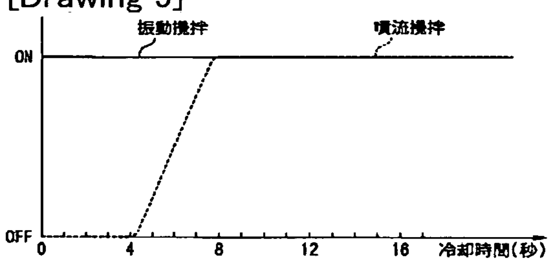

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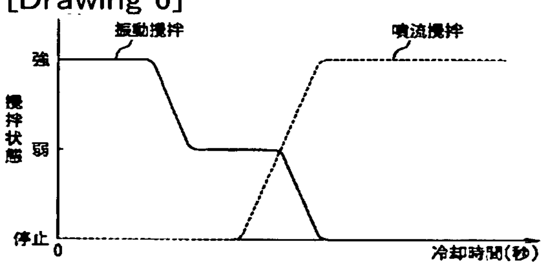

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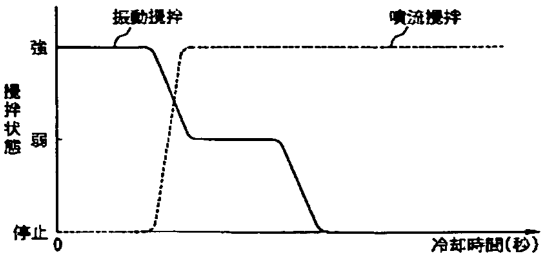
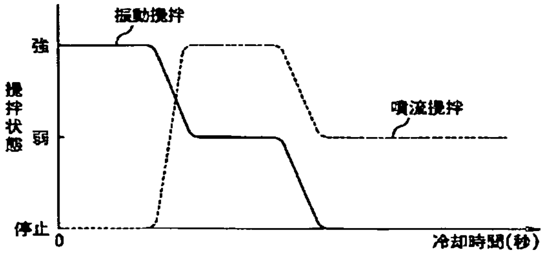


[Drawing 8]



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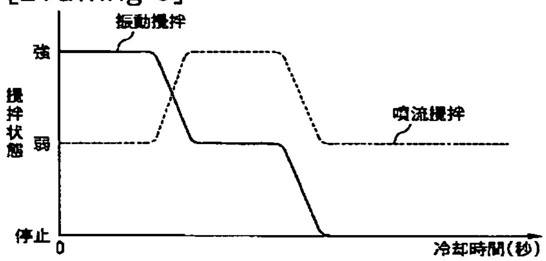
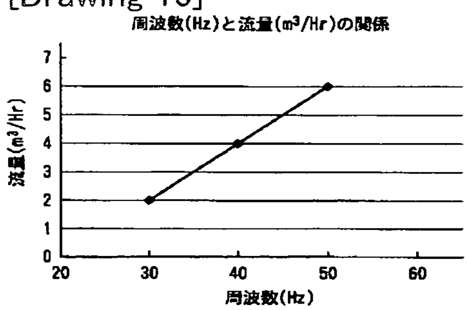
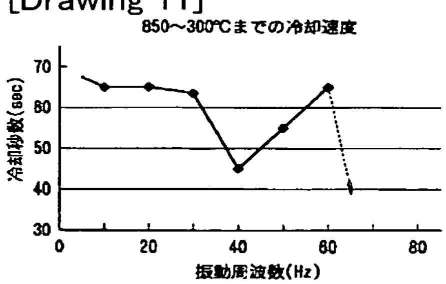


[Drawing 10]



[Drawing 11]



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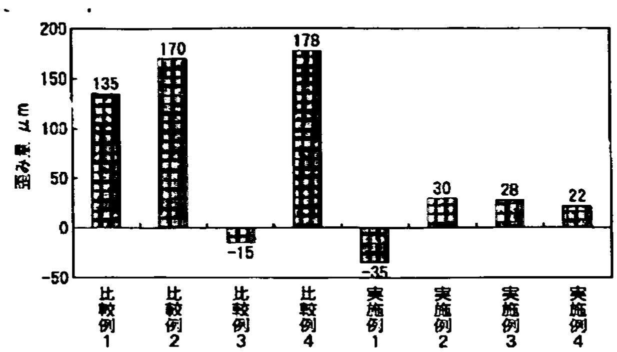
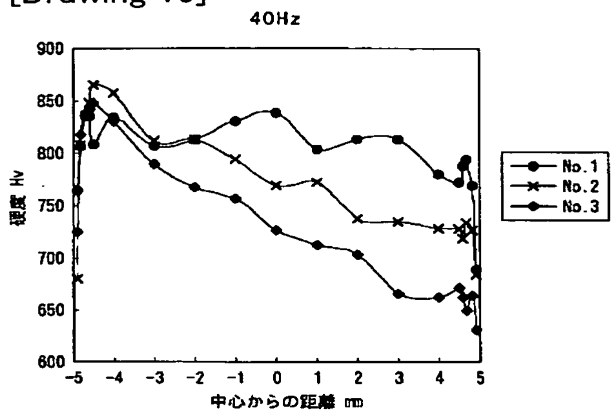
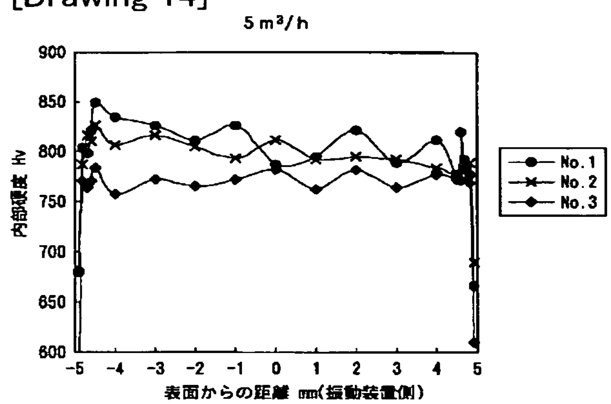


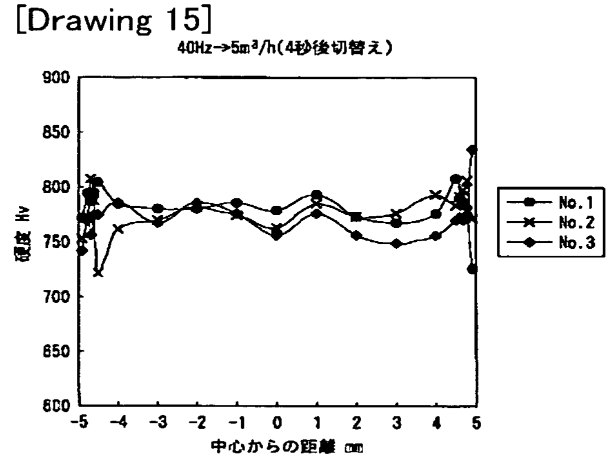
[Drawing 13]



[Drawing 14]



[Drawing 15]



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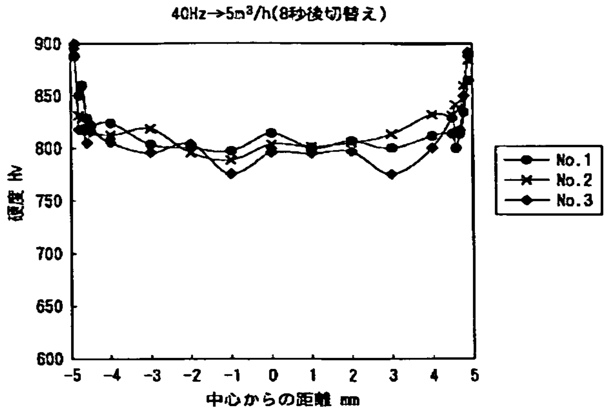

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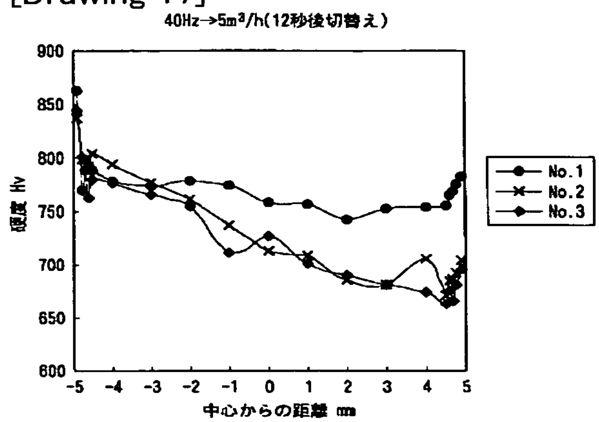

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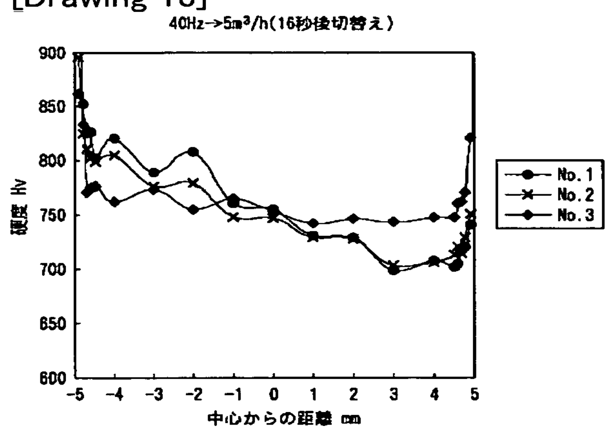

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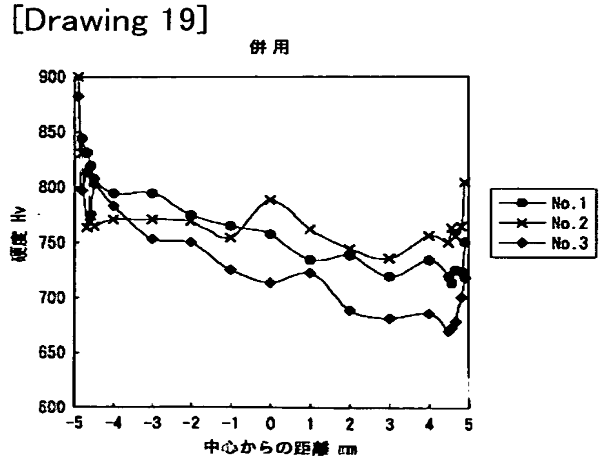
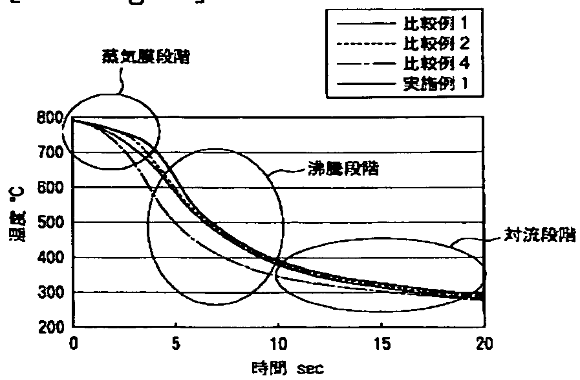
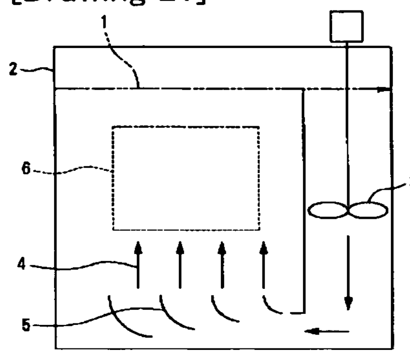


[Drawing 20]



[Drawing 21]



[Translation done.]